

THE WEATHER AND CIRCULATION¹ OF JULY 1964

A Warm Month Associated With Retrogression

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1. WEATHER HIGHLIGHTS

The contrast in regime between the Southeast and Northeast was one of the outstanding weather features of July 1964 in the contiguous United States. Record rains fell at some stations in the Southeast. Charleston, S.C., with 23.75 in., reported the wettest month ever observed (since 1738). Frequent showers and persistent cloudiness kept the weather cool with several cities reporting below normal temperatures every day of the month. In marked contrast with the cool wet conditions of the Southeast, in the Northeast it was generally warm and dry and many sections were suffering from drought for the third consecutive summer. Two of the driest areas this year were centered around Washington, D.C. and Albany, N.Y. Total rainfall at Washington was only 40 percent of normal for the period May through July, the driest such period of record (since 1871). At Albany, only 5.42 in. of rain (42 percent of normal) fell in the four months ending this July, the driest period since 1826.

Another persistently dry area was the Upper Mississippi Valley where, at the end of July, Rochester, Minn. had an annual precipitation deficiency of 9.20 in. Drought conditions were described as severe in southeastern Minnesota.

A heat wave in the Midwest during the latter half of the month produced temperatures of 110° F. in Kansas, 111° F. in Oklahoma, and 112° F. in South Dakota. At Wichita Falls, Tex., maximum daily temperatures averaged over 103° F. for July.

2. MEAN CIRCULATION

Important changes occurred in the mid-tropospheric circulation from June to July (fig. 1), as retrogression of the long waves over and near the United States accompanied the appearance of blocking in Canada. The ridge over the East in June [1] was located in the Great Plains in July. As a result of the change to more anticyclonic flow, the cool wet regime of June in the West was replaced

by warmer and drier conditions in July. The opposite change occurred in the Southeast where 700-mb. heights fell as the ridge in June gave way to a trough in July.

In the Pacific the westerlies moved northward from June to July concurrently with retrogression of strong blocking from the Bering Sea across northern Asia. The strong height rises in northern Russia (fig. 1) are evidence of this blocking wave. Blocking also appeared at middle latitudes in the Atlantic in July, while height falls, in association with a deepening Low, dominated the polar region.

The most unusual feature of the 700-mb. circulation for July (fig. 2) was the extremely deep polar Low. 700-mb. heights were below normal over the entire polar region, as much as -500 ft. near the pole (fig. 3), while sea level pressures averaged as much as 12 mb. below normal. Nothing comparable to a mean polar Low as intense as this has been observed in recent years in midsummer.

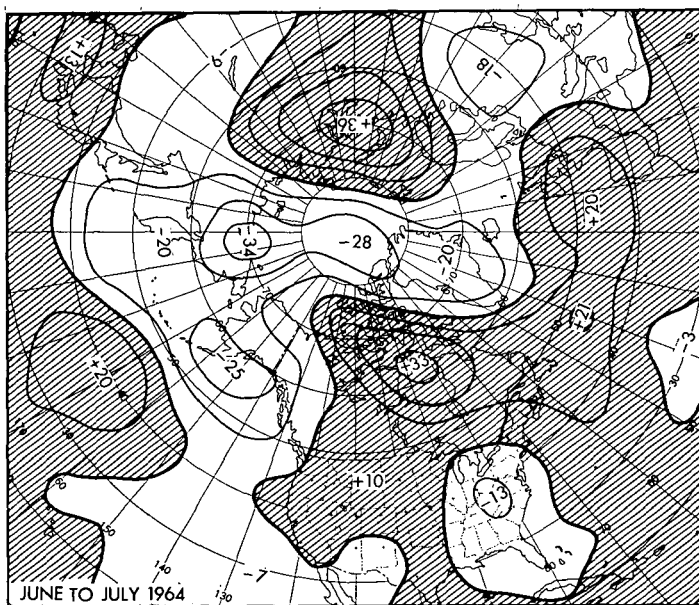


FIGURE 1.—Change of mean 700-mb. height anomaly (tens of ft., with positive changes shaded) from June to July 1964. Height rises in Canada attended blocking in North America.

¹ Beginning July 1, 1964, the Extended Forecast Division adopted new 700-mb. height and sea level pressure normals based on harmonic analysis of 16 years (1947-62) of daily data.

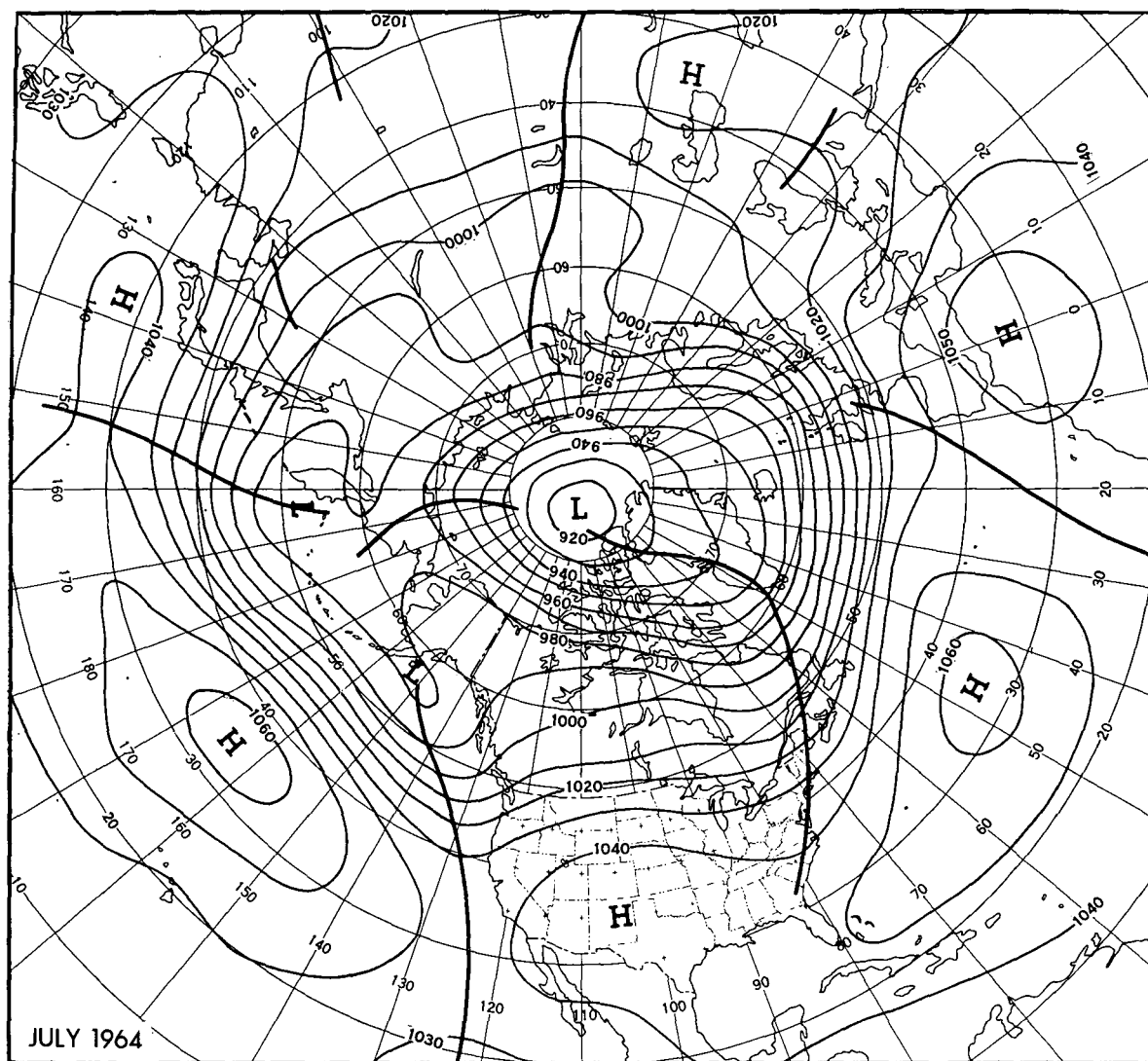


FIGURE 2.—Mean 700-mb. contours (tens of ft. at 100-ft. intervals) for July 1964. Deep polar Low was a prominent feature of the circulation.

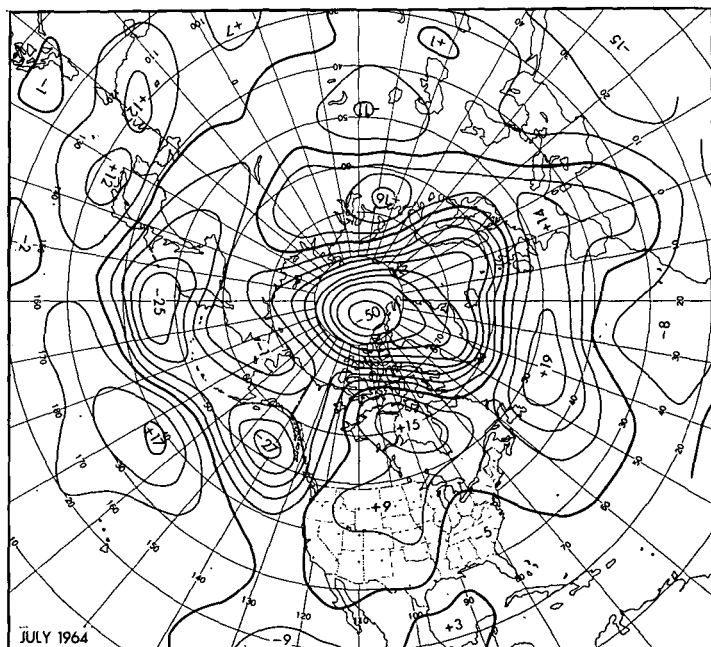


FIGURE 3.—Mean 700-mb. height departures from normal (tens of ft. and zero isopleth heavy) for July 1964. Greatest height departures from normal were located near the pole.

A well-defined westerly wind maximum circling the polar region (fig. 4) was associated with this system. The polar westerly index, a measure of the zonal wind speed between latitudes 55° and 70° N. in the western portion of the Northern Hemisphere, was 2.0 meters per second above its normal July value of 2.6 m.p.s. It is noteworthy that this index has been above normal during every month of 1964, an indication that the polar region has been dominated by negative height anomalies.

A simple planetary wave pattern prevailed in the Pacific with mean troughs located in extreme eastern and western portions (fig. 2). Both troughs were close to their usual July positions, but were deeper than normal at higher latitudes (fig. 3). The subtropical High was stronger than normal and displaced slightly north of its customary position. As a result of the zonally oriented pattern of 700-mb. height anomaly, the westerly jet axis

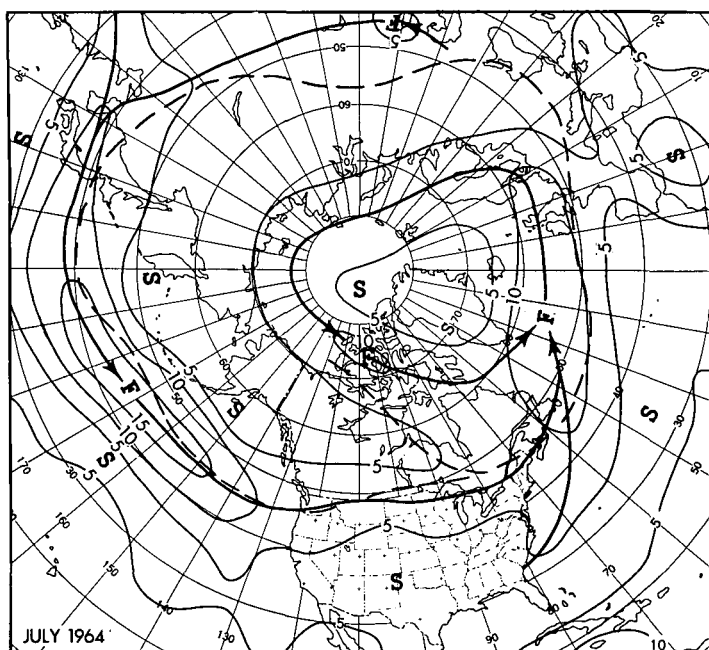


FIGURE 4.—Mean isotachs (meters per second) at 700 mb. for July 1964. Solid arrows indicate principal axes of maximum wind speed and dashed lines the July normal. Middle-latitude westerlies averaged slightly stronger than normal in the western portion of the Northern Hemisphere.

in the Pacific was well defined and stronger than normal.

Blocking was an important characteristic of the circulation in North America and the Atlantic. In North America it was associated with eastward displacement of the ridge normally found over the Canadian Rockies. The mean trough along the east coast of North America (fig. 2) was much deeper than normal at high latitudes (fig. 3) and also was displaced eastward to the west coast of Greenland, in harmony with the strong circulation around the polar Low. This trough was weaker than normal at middle latitudes and slightly deeper than normal along the South Atlantic Coast, a characteristic typical of blocking. A further manifestation of blocking over North America was the reduction in wind speed to mostly subnormal values in southern Canada and the United States. The jet maximum, however, was close to its usual July position (fig. 4).

In the Atlantic a similar relationship prevailed in association with the trough in that area. Here blocking was more intense, as shown by the strong easterly component of the height anomaly contours (fig. 3). Over the Atlantic the jet was displaced north of normal and wind speeds were well below normal at middle latitudes.

Blocking was also present at the higher latitudes in Asia where the center of maximum 700-mb. positive height anomaly was related to the strong ridge over northern Russia. The principal Asian trough, located immediately downstream, was weak in the north but deeper than normal in the south. Another reflection of blocking in Asia was

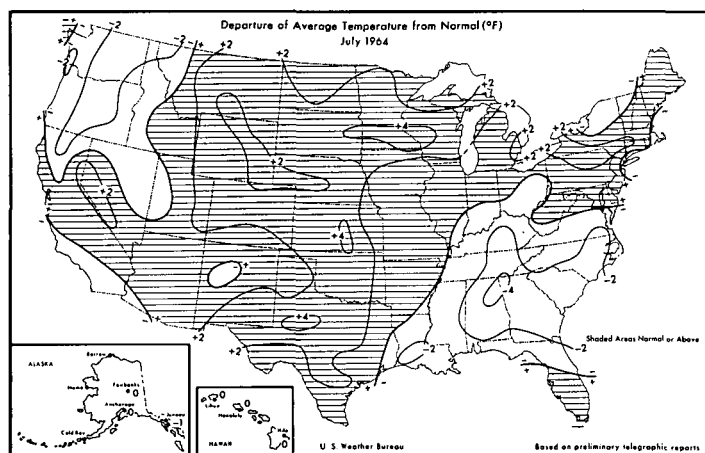


FIGURE 5.—Departure of average temperature from normal (°F.) for July 1964. Much of the United States was warmer than normal. (From [2].)

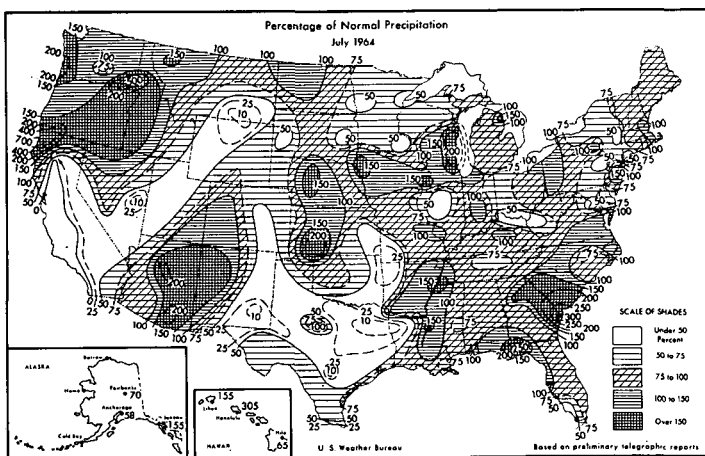


FIGURE 6.—Percentage of normal precipitation for July 1964. Heavy rains in the Southeast were more than twice the July normal in some areas. (From [2].)

the southward displacement of the primary axis of maximum west wind across Central Asia (fig. 4). Wind speeds in the jet increased to values well above normal as it moved off the Asian coast, a contributing factor being the strong High south of Japan.

3. WEATHER IN THE UNITED STATES

Warm and generally dry conditions prevailed in most of the Nation during July 1964. Temperatures averaged from 1° F. to as much as 4° F. above normal from the Mississippi Valley to the Rocky Mountain States, and also in parts of the Northeast and Southwest (fig. 5). Greatest departures and most persistent warmth occurred in the Great Plains and Rocky Mountain States. At Wichita Falls, Tex., maximum temperatures reached or exceeded 100° F. on 27 days of the month, while at Pueblo,

Colo., the average daily maximum temperature of 96.4° F. set a record for any month since 1888.

Precipitation was largely deficient in the area of above normal temperatures (fig. 6). While few records for dryness in July were established, the month continued a long period of moisture deficiency in many areas. This was particularly true in the Northeast where Concord, N.H. reported its sixth consecutive month of below normal precipitation and Charleston, W. Va. reached a 1964 deficiency of 8.40 in. In the Southern Plains, which were very dry in July, the rainfall deficiency reached 3 to 6 in. in many sections by the end of the month.

An exception to the dry pattern was the Central Plains where frontal systems accounted for sufficient shower activity to bring monthly precipitation totals slightly above the normal. At Milwaukee, Wis., heavy showers on the 17–18th (4 in. in 24 hr.) helped make this July the wettest of record (since 1871). Above normal precipitation also fell in eastern Arizona and western New Mexico primarily as a result of easterly wave activity aloft.

The extensive area of warm, mostly dry weather was related to the stronger than normal ridge over the Midwest. Note the good correspondence between the areas of positive 700-mb. height anomaly (fig. 2) and above normal temperature (fig. 5).

The deep trough off the west coast brought cool and rather wet weather to the Northwest in July. Fast westerly flow in the Pacific transported cool maritime air masses onto the continent where temperature departures of –2° F. or more were observed in the interior valleys. This was the wettest July in 60 years and second wettest since 1873 at Walla Walla, Wash.

July was much cooler and wetter than normal in the Southeast as a result of the deeper than normal trough along the South Atlantic Coast (figs. 2, 3). In addition to Charleston, S.C., other cities which set new rainfall records for the month were Savannah, Ga. (20.10 in.) and Tallahassee, Fla. (20.12 in.). Precipitation for 1964 ran well ahead of the normal for the January through July period in the Southeast. At Charleston and Tallahassee nearly twice the expected amount fell in the period, with totals already exceeding the annual normal. Charleston also had its coolest July of record. Frequent showers and an unusual amount of cloudiness contributed to the persistency of below normal temperatures. In some cities of South Carolina and Georgia every day of the month was either below normal or normal in temperature. This was the first July in 87 years of record at Atlanta, Ga. in which the temperature failed to reach 90° F.

4. HALF-MONTHLY CIRCULATION AND WEATHER PATTERNS

In some areas of the Nation weather conditions underwent an appreciable change near mid-month. This can

be related to changes in the half-monthly 700-mb. circulation patterns (figs. 7, 8).

JULY 1–15, 1964

An amplified wave pattern with blocking in Canada characterized the circulation over North America during the first half of the month. The stronger than normal mid-continent ridge associated with the blocking was flanked by deeper than normal troughs in the eastern Pacific and the East Coast States.

Temperatures averaged up to 2° F. below normal in the Great Basin and Pacific Coast States in the first half of the month (fig. 7B). Cold Pacific air dropped the temperature to 52° F. at Red Bluff, Calif. on the 4th, a record for any July (since 1877). Elsewhere in the West most temperatures were a few degrees above normal, in accordance with above normal 700-mb. heights. Record daily maximum temperatures observed at some stations in the Great Plains from the 4th to the 8th were associated with marked anticyclonic flow aloft. For example, it was 108° F. at Goodland, Kans. on the 4th and at Concordia, Kans. on the 6th, and 105° F. at Little Rock, Ark. on the 7th and 8th. Precipitation amounts during the first half of July were insignificant in the West, except in the Northwest and along the northern border (fig. 7C) where showers were frequent.

Most of the eastern half of the Nation was cool with temperature departures ranging to 4° F. below normal in the Ohio and Tennessee Valleys (fig. 7B). Springfield, Mo. recorded its lowest temperature for any July (77 years) with 50° F. on the 13th. Disturbances moving from the Plains States were responsible for much of the precipitation from the Central Plains to the east coast. Amounts ranged from 1 to 3 in. More than 7 in. fell in Trenton, N.J., however, and the drought in that area was greatly alleviated.

JULY 16–31, 1964

Relaxation of blocking over North America during the last half of the month was accompanied by increasing westerlies and progression of the long waves. The western ridge moved to the Great Lakes as the eastern trough advanced to the Atlantic coast and weakened considerably (fig. 8A). As a result the above normal temperature in the West shifted eastward to include all but the Southeast and areas along the North Atlantic Coast (fig. 8B). An extensive heat wave developed from the Great Plains to the Lakes Region as the Midwest ridge strengthened. Temperature departures from normal rose as much as 6° F. in the Central States as the area of negative 700-mb. height anomaly centered in the Ohio Valley (fig. 7A) was replaced by positive anomaly (fig. 8A). Maximum temperatures reached or exceeded 100° F. in most sections between the Rockies and Mississippi

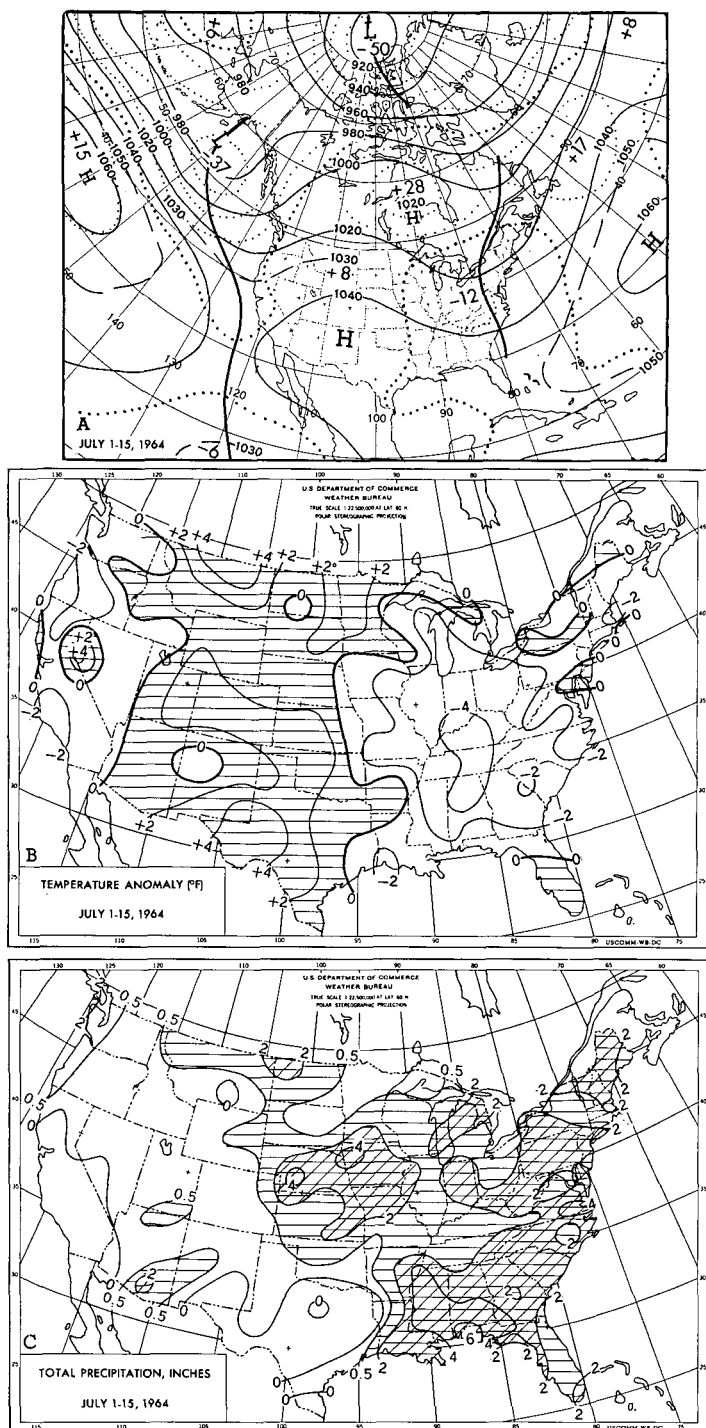


FIGURE 7.—(A) 700-mb. height and departure from normal (both in tens of ft.); (B) departure of average temperature from normal (°F., above normal shaded); (C) total precipitation (inches, less than 0.5 in. unshaded, 0.5 to 2 in. hatched, more than 2 in. crosshatched); all for July 1-15, 1964.

River during the week ending July 27. In southwestern Oklahoma, however, there were 27 consecutive days of such temperatures.

Drier conditions prevailed in the Northeast during the last half of July (fig. 8C) as the eastern trough moved

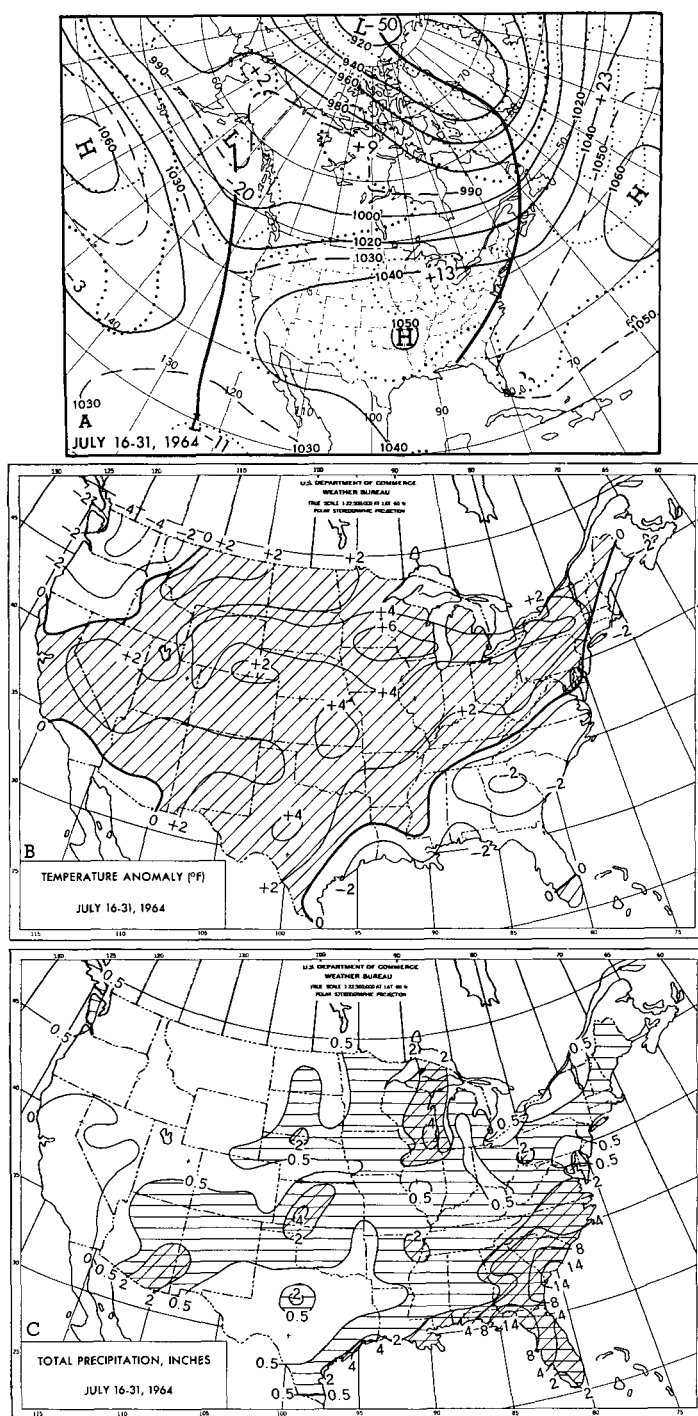


FIGURE 8.—(A) 700-mb. height and departure from normal (both in tens of ft.); (B) departure of average temperature from normal (°F., above normal shaded); (C) total precipitation (inches, less than 0.5 in. unshaded, 0.5 to 2 in. hatched, more than 2 in. crosshatched); all for July 16-31, 1964.

off the coast. Elsewhere there was little change in the pattern of precipitation across the Nation except in the Southeast. In that area filling of the east coast trough and northward shifting of the westerlies brought much heavier precipitation, particularly to coastal sections.

Heavy amounts were favored by a shift in the 700-mb. anomalous flow from westerly to easterly. Frontal systems were largely responsible for the precipitation in the first half of the month; during the latter half, shower activity was tropical in nature.

5. TROPICAL STORMS

Tropical storm activity in July was confined primarily to the western Pacific where there were eight such storms. Most of these drifted slowly westward and weakened before reaching the Asiatic Coast. This was in accord with the strong upper High centered south of Japan (figs. 2, 3). Only typhoon Flossie recurved northward along the China Coast on the 27th and 28th, and then moved across North Korea on the 29th. At the end of the month typhoon Helen was moving northwestward toward Kyushu, Japan.

Three tropical storms were observed in the eastern Pacific. Of these, only hurricane Odessa affected any

land masses. This storm developed off the coast of Mexico near mid-month and moved westward, reaching the Hawaiian Islands as an easterly wave. Here the remnant of the storm produced a rainy, cloudy period from the 23d to the 25th, and was largely responsible for above normal amounts of precipitation in the northern islands in July (fig. 6).

No tropical storms were observed in the Caribbean or Gulf of Mexico in July. Late in the month, however, a disturbance of tropical origin developed well east of the Lesser Antilles and moved northward without striking any land areas.

REFERENCES

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2. U.S. Weather Bureau, *Weekly Weather and Crop Bulletin*, *National Summary*, vol. LI, Nos. 31, 32, Aug. 3, 10, 1964.